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INVESTIGATION ON THE FORAGING POWERS OF SOME AGRICULTURAL PLANTS FOR PHOSPHORIC ACID.*

PROF. WALTER BALENTINE.

Of recent investigations in plant nutrition those establishing the fact that leguminous plants are able to gather a portion of their nitrogen either directly or indirectly from the free nitrogen of the air are by far the most important, both from the scientific and the practical stand points.

These investigations settle a question that has attracted the attention of agricultural chemists for half a century. On the practical side the results enable us to say, that it is possible, by growing and feeding to farm animals such plants as peas and clover, to increase the stock of nitrogen for manurial purposes without resorting to the various expensive commercial nitrogenous materials.

Stating the results of these investigations concisely, it has been found that the leguminous plants are able to forage on the atmosphere for a portion of their nitrogen. Other plants either possess this power to a much less degree or not at all. If we look for a reason why this family of plants has attracted so much attention from scientists we find it in the fact that some of its members, the clovers especially, have been found in practical farming to be plants which by their growth on the soil, apparently leave it richer in plant food than before, and that farmers are actually able to produce more of grass, grain and potatoes when clover is used as one of the crops in rotation. It was to learn why a plant that takes up such large quantities of nitrogen as clover, should

* This bulletin is an extract from the report of Prof. Balentine in the station report for 1893.—W. H. J.

still leave the ground in a better condition for succeeding crops, that the sources of supply of nitrogen to the leguminous plants have been so carefully studied.

The value of the results of this work to the agriculture of the world cannot be over-estimated. There are, however, other problems in plant nutrition which deserve as careful study as the nitrogen question and which may yield results of equal practical importance.

All who have given especial attention to the subject of plant nutrition will, undoubtedly, agree that the foraging powers of plants for the elements contained in the ash, vary greatly. This fact is recognized by the majority of observing farmers, as is shown by the following common sayings: "Wheat requires a rich soil." "Corn is a gross feeder." "Oats are an exhaustive crop."

Notwithstanding that these views regarding the variation in foraging powers of different crops have been held by many for years, no one is prepared to say just how it is exerted. We are hardly ready to express an opinion whether the greater vigor of certain plants as compared to other species grown on the same soil is due to their superior foraging powers for all of the elements contained in their ash, or for one or more particular elements.

It seems quite as likely, however, that some plants are able to use certain soil compounds of potash or phosphoric acid, which are not available to other plants, as it did that the legumes were able to obtain nitrogen from sources that were not available to the grasses.

Believing that a study of the foraging powers of different agricultural plants would reveal facts of scientific interest, and at the same time of practical value to agriculture, the writer commenced a series of experiments, in the fall of 1892, designed to test the readiness with which different plants obtain their phosphoric acid from insoluble phosphates.

The reason why phosphoric acid was selected on which to make these first studies, in preference to any other substance was, that in practical manuring with crude phosphates, and also in their use in experimental work, different crops had apparently showed decided differences in their abilities to gather phosphoric acid from such a source.

EXPERIMENTAL METHODS.

In order to have the work as much as possible under control the experiments were conducted in boxes in the college forcing house.

These boxes were of wood, fifteen inches square and twelve inches deep. For soil a fine sand was used, taken from a sand bank about three feet below the surface. This sand was drawn to the forcing house, screened and thoroughly mixed by repeatedly shoveling it over, after which a sample was taken and the content of potash and phosphoric acid determined, with the following result: Potash, 0.096; phosphoric acid, 0.012 per cent.

One hundred and twenty pounds of sand were used in each box.

For each kind of plant studied nine boxes were used, in three sets of three boxes each.

The three boxes of each set received the following manuring per box:

SET I { 8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.

SET II { 8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.
17.0 grams South Carolina rock = 4.35 grams insoluble phosphoric acid.

SET III { 8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.
28.5 grams acidulated South Carolina rock = 4.46 grams phosphoric acid, three-fourths water soluble.

It will be seen that all of the boxes were treated alike with reference to potash and nitrogen, that the plants grown in Set I were dependent on the phosphoric acid originally in the sand, that those grown in Set II had in addition 4.32 grams of phosphoric acid, mostly insoluble, supplied by crude finely ground South Carolina rock, and that those grown in the boxes of Set III had in addition to that originally contained in the sand 4.46 grams of phosphoric acid, mostly soluble, supplied in acidulated South Carolina rock.

The plants thus far studied have been wheat, barley, corn, beans, peas, potatoes and turnips.

After planting, the boxes were under the care of a man experienced in growing plants under glass. Water was supplied as it was believed to be needed. At the proper time the plants were thinned so that the boxes having the same kind of plants contained the same number of plants to the box.

The plants were allowed to grow to maturity. Immediately before harvesting, the crops were photographed and plates made showing the relative development of the plants produced. At the time of harvesting, the crops of wheat, barley, corn, peas and beans produced in each box were weighed separately in an air dry

condition, after which the amount of dry matter was determined in the combined crop of the three boxes of each set.

	Dry matter produced in each set of three boxes.						
	Wheat.	Barley.	Corn.	Beans.	Peas.	Potatoes.	Turnips.
	grams	grams	grams	grams	grams	grams	grams
Only soil phosphoric acid.....	76.9	201.5	39.5	15.7	112.7	113.3	154.4
Water-insoluble phosphoric acid..	148.6	294.9	103.3	17.4	196.7	114.6	304.1
Mostly water-soluble phos. acid...	296.3	508.1	291.0	69.8	228.6	223.6	270.4

While it may not be desirable to draw definite conclusions from so small an amount of data as is furnished by the above described experiments, there are some points which under the conditions of these experiments the results appear to bring out sharply.

1st. Different crops showed a decided difference in their powers of obtaining phosphoric acid from crude, finely ground South Carolina rock. Wheat, barley, corn, peas and turnips apparently appropriated the insoluble phosphoric acid from this source with greater or less ease, while beans and potatoes derived no benefit from it.

2d. The greatest practical advantage derived from the use of fine ground South Carolina rock was with the turnips. With this crop a larger weight of dry matter and also a larger weight of fresh roots was obtained with insoluble phosphoric acid from the finely ground South Carolina rock than with an equal amount of soluble phosphoric acid from acidulated South Carolina rock.

3d. The indications point to a profitable use of finely ground South Carolina rock as a manure for barley and peas as well as turnips.

4th. The acidulated South Carolina rock in these experiments apparently depressed the yield of grain with barley while largely increasing the amount of straw. With wheat both grain and straw were largely increased and in about the same proportion.

MAINE STATE COLLEGE,
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NOTE. These investigations are being continued and will be kept up, if possible, until the results warrant definite conclusions. Additional data are already obtained and experiments are now in progress. W. H. J.